

**Alaska Department of Fish and Game  
Division of Wildlife Conservation  
December 1999**

# **Investigation of Wolf Population Response to Intensive Trapping in the Presence of High Ungulate Biomass**

**Mark E. McNay**

**Research Performance Report  
1 July 1998–30 June 1999  
Federal Aid in Wildlife Restoration  
Grant W-27-2, Project 14.17**

This is a progress report on continuing research. Information may be refined at a later date.

If using information from this report, please credit author(s) and the Alaska Department of Fish and Game.

## RESEARCH PROGRESS REPORT

**STATE:** Alaska **STUDY:** 14.17

**COOPERATOR:** Layne Adams

**GRANT:** W-27-2

**TITLE:** Investigation of Wolf Population Response to Intensive Trapping in the Presence of High Ungulate Biomass

**AUTHORS:** Mark E McNay, Bruce Dale, Tom Stephenson, and Jay Ver Hoef

**PERIOD:** 1 July 1998–30 June 1999

### SUMMARY

Since 1954, the wolf (*Canis lupus*) population in Unit 20A has been reduced 3 times by government wolf control programs and has continuously sustained annual harvests by the public under liberal hunting and trapping regulations. The latest wolf control program ended in December 1994. We initiated this study in March 1995 to document effects of wolf control on wolf population dynamics and to monitor the wolf population's recovery in the presence of high ungulate biomass and continued moderate harvest of wolves by public hunters and trappers.

The 1 November 1998 wolf population contained 169 wolves in 19 radiocollared wolf packs ( $\bar{x} = 8.9$  wolves per pack). Five radiocollared wolves were singles, not associated with packs, so the minimum known population size was 174 wolves. After adjusting the minimum population for uncollared single wolves, the total estimated population size within the 11,275-km<sup>2</sup> study area was 184 wolves (16.3 wolves/1000 km<sup>2</sup>). Single wolves composed 8% of the adjusted estimate.

We captured and marked 51 wolves between 1 October 1998 and 5 April 1999. Among those, 17 were adult females captured in April to determine pregnancy by ultrasound. Thirteen of the 17 were pregnant; estimated in utero litter sizes ranged from 2–8 ( $\bar{x} = 5.3$ ).

We estimated kill rates of 9 wolf packs from aerial surveys conducted during 10, 4-day sampling periods between 8 November and 18 March. We observed remains of 38 moose (*Alces alces*), 7 caribou (*Rangifer tarandus*), and 2 Dall sheep (*Ovis dalli*) kills during the sampling periods. By helicopter, we visited 41 kill sites. We collected bone marrow samples from 17 of the moose kills.

Between 1 July 1998 and 30 June 1999, 25 radiocollared wolves died within the study area and 4 collared wolves died outside the study area. Of the 29 mortalities, hunters or trappers killed 25, 3 died of natural causes, and 1 died as a result of capture for this study. We conducted postmortem examinations on 61 wolf carcasses purchased from hunters and trappers. We measured carcasses, removed and dissected female reproductive tracts, counted placental scars, excised and weighed xiphoid fat, collected tissue for genetic analysis and noted injuries.

**Key words:** kill rates, litter size, postmortem examination, pregnancy rates, trapping, wolf control, wolves.

## CONTENTS

SUMMARY .....	i
BACKGROUND.....	1
STUDY OBJECTIVES .....	3
JOB OBJECTIVES.....	3
STUDY AREA.....	5
METHODS .....	5
WOLF CAPTURE AND HANDLING .....	5
<i>Jobs 2, 3, 4, 6, and 7</i> .....	5
WOLF POPULATION SIZE AND TELEMETRY LOCATIONS .....	5
<i>Jobs 4, 5, 6, 7 and 9</i> .....	5
PUP PRODUCTION AND SURVIVAL .....	6
<i>Jobs 2 through 5</i> .....	6
KILL RATES AND COMPOSITION OF PREY .....	6
<i>Jobs 2, 4, 6 and 8</i> .....	6
POSTMORTEM EXAMINATIONS .....	7
<i>Jobs 9 and 10</i> .....	7
RESULTS AND DISCUSSION .....	7
WOLF CAPTURE AND HANDLING .....	7
<i>Jobs 2, 3, 4, 6, and 7</i> .....	7
WOLF POPULATION SIZE AND TELEMETRY LOCATIONS .....	7
<i>Jobs 4, 5, 6, 7 and 9</i> .....	7
PUP PRODUCTION AND SURVIVAL .....	8
<i>Jobs 2 through 5</i> .....	8
KILL RATES AND COMPOSITION OF PREY .....	8
<i>Jobs 2, 4, 6, and 8</i> .....	8
MORTALITY AND POSTMORTEM EXAMINATION .....	9
<i>Jobs 9 and 10</i> .....	9
CONCLUSIONS AND RECOMMENDATIONS.....	9
ACKNOWLEDGMENTS.....	9
LITERATURE CITED .....	10
Table 1 Estimated pack size and number of autumn pups among 19 radiocollared wolf packs in Unit 20A, November 1999.....	12

## BACKGROUND

The history of wolf (*Canis lupus*) harvest and wolf population response to that harvest was documented by Gasaway et al. (1983) and Boertje et al. (1996). Between 1954 and 1960, the Unit 20A wolf population was reduced by poisoning and aerial shooting to a density of approximately 4 wolves/1000 km<sup>2</sup>. Following cessation of wolf control in 1960, wolves increased and attained densities of 16 wolves/1000 km<sup>2</sup> by 1970. Moose (*Alces alces*) increased to high densities ( $\geq 1300$  moose/1000 km<sup>2</sup>) by the mid-1960s, then declined to a low density (165 moose/1000 km<sup>2</sup>) by 1975. Between 1976 and 1979, wolves were again reduced by aerial shooting to a density of 3 wolves/1000 km<sup>2</sup>. Moose, caribou (*Rangifer tarandus*),

and wolf populations all increased during the 1980s, and wolves reached a density of 16 wolves/1000 km<sup>2</sup> by autumn 1991. Wolves were reduced during a third government wolf control program during winters 1993–1994 and 1994–1995.

Wolf populations recovered rapidly in Unit 20A following wolf control in the 1950s and 1970s. The rates of recovery are consistent with findings of high pregnancy rates and reproductive success of Alaskan wolves subjected to high rates of harvest (Rausch 1967). Woolpy (1968; cited by Packard and Mech 1980) speculated that the uncharacteristically high pregnancy and birth rates were linked to harvests because high harvests, presumably, disrupt wolf social restrictions on breeding. If so, pregnancy rates among unexploited populations should be lower than among highly exploited populations.

Harvests of 15–40% (Gasaway et al. 1983; Ballard et al. 1987; Fuller 1989) have stabilized wolf populations, but the mechanisms by which unexploited or lightly exploited populations are regulated are not always clear. Packard and Mech (1980) reviewed the concept of "intrinsic limitation" and found it inadequate to explain wolf population regulation in many cases. While social factors may buffer wolf numerical responses to prey fluctuations (Packard et al. 1983), nutrition probably has the greatest ultimate influence on wolf population regulation in unexploited and lightly exploited populations. Changes in prey vulnerability, time lags in the numerical response to changes in nutrition (Packard and Mech 1980), and varying rates of exploitation by humans contribute to difficulties in deciphering the influence of intrinsic social mechanisms.

The most recent wolf control program (1993–1994) was conducted to halt a precipitous decline in caribou numbers that occurred during a series of severe winters (Boertje et al. 1996). However, the moose population did not significantly decline during those winters, and moose population density is now approximately 675 moose/1000 km<sup>2</sup>. After wolf control ended, caribou numbers stabilized. Consequently, the reduced wolf population is recovering in the presence of relatively high prey numbers. Based on regressions of ungulate biomass versus wolf density from study areas throughout North America (Fuller 1989; Messier 1995), the ungulate prey base in Unit 20A could support a wolf density of 20–25 wolves /1000 km<sup>2</sup>. Those densities are 25–56% higher than previously recorded in Interior Alaska (Boertje et al. 1996). Therefore, if social limitation is of major importance (Haber 1996) in limiting wolf population size, it should have ample opportunity to express itself in the Unit 20A wolf population. If wolves do stabilize at moderate densities, we have a rare opportunity to examine the potential for a high-density ungulate–wolf equilibrium in which wolves are socially regulated below a level that food limitation is imposed and ungulates remain at high density, despite relatively high wolf numbers.

The history of periodically intense wolf harvest in Unit 20A has caused redistribution of pack territories and may have affected reproductive success of surviving females. In contrast, within the adjacent Denali National Park, legal harvest of wolves has been prohibited since 1952. On lands added to the park by the Alaska National Interest Lands Conservation Act (ANILCA) in 1980, wolves were occasionally harvested by subsistence users and in some areas legally by sport hunters, but harvests were very low. We know of only 3 wolves

harvested by humans within the entire 14,200-km<sup>2</sup> Denali Park and Preserve Conservation Unit between 1986 and 1992 (Meir et al. 1995).

The genetic relatedness (Lehman et al. 1992), social structure, natural mortality, dispersal, reproductive characteristics (Meir et al. 1995), and predation characteristics (Adams et al. 1995; Mech et al. 1995; Mech et al. 1998) of the unexploited Denali wolf population have been well documented. National Park Service biologists continued to monitor approximately 10 radiocollared packs within the park and preserve between 1992 and 1996 (B Dale, personal communication).

## STUDY OBJECTIVES

- 1 Document effects of intensive trapping on wolf pack structure and viability, based on breeding characteristics and productivity, ages and rates of dispersal, causes and rates of natural mortality, and spatial distribution of individuals and packs.
- 2 Evaluate those effects relative to current wolf harvest management practices in consideration of public concerns regarding the potential for long-term detrimental effects arising from human exploitation of wolves.

## JOB OBJECTIVES

The procedures for the proposed objectives are listed with each objective.

- 1 Compile results of ground-based wolf control conducted by intensive trapping in Unit 20A. Existing records contain data on composition of the harvest, geographical distribution of the harvest, distribution of harvest among packs, efficacy of the trapping effort, estimates of population size, and reproductive performance of the precontrol wolf population. These data will be compiled to serve as a basis for comparison to data collected during wolf population recovery.
- 2 During each year of the study, maintain a sample of at least 40 radiocollared wolves comprising at least 30 females in at least 10 packs that currently are within the core wolf control area. Radiomarked packs will be captured at least once each year to place radio collars on adult female wolves and to apply earmarks to juvenile females so that a known-aged sample of females is maintained within the population.
- 3 Determine pregnancy rates and fetal litter sizes using ultrasound scanning in early April each year. Radiocollared adult females (age  $\geq 22$  mo) will be recaptured approximately 20–30 days following the end of the breeding season to determine frequency of pregnancy and in utero litter size. Other adult females that are not radiocollared but associated with the pack will also be captured and added to the collared sample of adult females.
- 4 Determine movements, dispersal activities, and denning locations of known pregnant females during the last half of pregnancy and during the first 2 weeks following the estimated parturition date for each female. Females that are known to be pregnant

based on ultrasound results will be located approximately 3 times each week between early April and mid June. Parturition dates will be estimated based upon dates of den entrance.

- 5 Determine oversummer wolf pup survival. Selected dens will be monitored beginning 3 weeks after parturition to estimate litter sizes at birth. Using spotting scopes, we will view dens from the ground. Late summer estimates of pup survival will be based on aerial observations of wolves at summer rendezvous sites or aerial observations of traveling packs during late September and early October.
- 6 Determine annual wolf population estimates during autumn and spring. Population estimates will be based on the maximum number of wolves seen in radiocollared wolf packs during early autumn and additional wolves detected during aerial surveys not associated with packs. Fixed-wing aerial surveys will be conducted 2–5 days after a fresh snowfall during the autumn period (Oct–Nov) and during the spring period (Mar–Apr) to search for unmarked wolf packs.
- 7 Determine wolf pack territory size based on a minimum of 40 locations per wolf pack per year. During each month of the year, radiotracking flights will be conducted to determine wolf pack movements and annual home range size.
- 8 Cooperate with studies on moose and caribou to maintain accurate estimates of moose and caribou population size and distribution over time and relative to changes in wolf density. Periodic assistance will be provided to caribou and moose research programs to ensure that prey distribution data are regularly collected. We will conduct monthly caribou radiotracking and autumn moose distribution flights.
- 9 Investigate and determine the causes of wolf mortality. A helicopter will be used to visit sites where wolf mortality signals are detected. Remains of wolf carcasses will be collected and analyzed for cause of death when cause is not apparent from on-site evidence.
- 10 Determine sex and age of wolves taken by public trappers and hunters within the study area. The vulnerability of various sex and age classes to hunting and trapping will be determined by comparing the sex and age of the harvest with population sex and age composition estimated from radiolocation and capture data.
- 11 Conduct literature review. References to canid dispersal, mortality, reproductive success, and predator–prey relationships will be reviewed and incorporated into design of data analysis.
- 12 Analyze data and prepare figures and text for publication and oral presentations.
- 13 Write annual progress reports and a final report at the end of the study period.

## STUDY AREA

The study area lies within Unit 20A (17,601 km<sup>2</sup>) of Interior Alaska. Elevations within the study area range from 110–4000 m, but most wolves and their prey are at elevations below 2000 m. As the terrain slopes upward from north to south, the habitat changes from poorly drained “flats” of boreal spruce forest underlain by permafrost through a zone of alpine shrubs and into an alpine community of grasses, sedges, and forbs. Elevations above 2000 m are often covered by permanent snow or glacial ice.

Wolves prey primarily on moose, caribou, and Dall sheep (*Ovis dalli*). A small herd of approximately 400 bison (*Bison bison*) occupy grass/sedge meadows along the eastern edge of the study area in summer and autumn. Bison are available as prey for only 1 wolf pack within the study area. Other wolf prey include beavers (*Castor canadensis*), snowshoe hares (*Lepus americanus*), and ground squirrels (*Spermophilus undulatus*). Beavers are common in the drainages along the foothills of the Alaska Range. Snowshoe hare numbers increased during the study period as they approached the high of their 10-year cycle. Other potential ungulate predators include black bears (*Ursus americanus*), grizzly bears (*Ursus arctos*), coyotes (*Canis latrans*), wolverine (*Gulo gulo*), and lynx (*Felis lynx*). Golden eagles (*Aquila chrysaetos*) also prey on newborn caribou and Dall sheep.

The area is roadless except for seasonal mining trails and trails to homestead sites along the western boundary of the area. Two families occupy permanent homestead sites in the center of the study area. The community complexes of Healy/McKinley Park and Delta Junction/Fort Greely lie outside the western and eastern boundaries, respectively. Denali National Park lies adjacent to the study area to the west. Access to the study area is by air via numerous airstrips associated with mining or guiding, or unimproved landing sites along streams and ridges.

## METHODS

### WOLF CAPTURE AND HANDLING

*Jobs 2, 3, 4, 6, and 7*

From helicopters, we darted wolves, using 3cc Palmer Cap-Chur<sup>®</sup> (Douglasville, Georgia, USA) darts loaded with 560 mg of Telazol<sup>®</sup> (tiletamine HCL and zolazepam HCL, Fort Dodge Lab, Fort Dodge, Iowa, USA) and propelled by low velocity (brown) charges. Wolves were either eartagged or fitted with radio collars containing a mortality-sensing device (Telonics, Inc. Mesa, Arizona USA). In early April we scanned adult female wolves with a portable ultrasound machine to determine pregnancy, litter size, and rumpfat thickness.

### WOLF POPULATION SIZE AND TELEMETRY LOCATIONS

*Jobs 4, 5, 6, 7 and 9*

We conducted radiotracking flights from fixed-wing aircraft throughout the reporting period. Location, pack size, color composition, cover type, activity, and weather information were recorded for each observation. Wolf population estimates were primarily based on wolves

associated with radiocollared packs and single, collared wolves. When noncollared packs or single wolves were observed, they were included in population estimates.

We compiled age and sex composition of monitored wolf packs from capture and harvest. When possible, each carcass purchased from hunters and trappers was assigned to a pack based on the catch location, color, age, and hunter or trapper observations of other wolves at the site. Telemetry flights were frequent and it was often possible to match the timing and location of a given wolf pack with the timing and location of a given catch by a hunter or trapper. In addition, the chronology of change in wolf pack size observed during telemetry flights was matched with the chronology of harvest reported by individual trappers and hunters. When a harvested wolf could not clearly be associated with a given wolf pack, pack association was recorded as unknown.

## **PUP PRODUCTION AND SURVIVAL**

### *Jobs 2 through 5*

Pregnant females were located on average every third day during late April and early May of 1998 and 1999. One den site was observed using spotting scopes from the ground in early June 1998 to determine litter size of the female that had been scanned with ultrasound in April. The remainder of the 1998 and 1999 dens was not viewable from the ground. From fixed-wing aircraft, we estimated summer litter sizes for most packs during late summer when wolves moved their pups to rendezvous sites. Autumn pup counts were made during telemetry flights in late September through early November when pups were traveling with packs. Pups were identified from the air based on their size, behavior, pelage quality, and stamina. On many flights, pups were sighted but vegetation prevented a clear view, or terrain prevented low-level maneuvering of the aircraft. Those counts were not censored. Each usable count was obtained and repeated during multiple passes by the aircraft over the wolf pack, with the pack in clear view.

## **KILL RATES AND COMPOSITION OF PREY**

### *Jobs 2, 4, 6 and 8*

During winter 1998–1999, from the air we intensively monitored 9 wolf packs to determine kill rates and composition of prey. During each 2-week period between 1 November and 20 March, we monitored each pack for periods of 4 consecutive days. The randomly selected starting day of each monitoring period was used to establish the location and activity of each pack. The next 3 days of each period were considered sampling days, and we recorded locations and species of kills made by each pack, and the distance from the previous day's location. This sampling regime resulted from simulations of various interval sampling designs using empirical wolf kill rates from a moose-caribou prey system in northwestern Alaska (Ballard et al. 1997) and composition of kill data from a moose-caribou prey system in Interior Alaska (Mech et al. 1995).

At the end of each sampling period, we visited kill sites via helicopter to determine sex and age of the prey and to collect long bones for analysis of bone marrow fat in the prey animal. Marrow samples were extracted from long bones, weighed, and then dried at 60 C until no

further weight loss could be detected. Percent fat was determined using the dry weight method described by Neiland (1970).

Distribution of caribou within the kill rate study area was determined by locating all radiocollared caribou within the study area during each sampling period. Distribution of moose within the study area was estimated from stratification and composition data collected during November aerial surveys of moose.

## **POSTMORTEM EXAMINATIONS**

### *Jobs 9 and 10*

We purchased wolf carcasses from private trappers. During postmortem examinations we recorded location, method and date of take, and body measurements. Female reproductive tracts were removed and dissected. We counted placental scars, excised and weighed xiphoid fat, collected tissue, and noted injuries. Skulls were cleaned and 2 premolars (an upper and lower) were extracted for cementum aging from animals more than 1 year of age. First year animals were aged on evidence of incomplete epiphysal closure in the radius and ulna. When possible we assigned a pack affiliation to each harvested wolf.

## **RESULTS AND DISCUSSION**

### **WOLF CAPTURE AND HANDLING**

#### *Jobs 2, 3, 4, 6, and 7*

We captured 51 wolves between 1 October 1998 and 5 April 1999; 20 of those wolves had been previously marked and were recaptured to determine pregnancy (i.e., ultrasound) or to replace failing radio collars. One wolf, female No. 297, died 4 days after capture, apparently as a result of a dart wound inflicted during capture. Postmortem examination in the field revealed blood in the chest cavity and hemorrhaging in 1 lung. However, during capture and recovery following capture, there was no behavioral or external sign of injury. Among the 245 captures completed during this study since 1995, 4 wolves (1.6%) have died as a result of capture. In addition to female No. 297, 1 wolf suffocated in deep snow before the handling crew arrived on the ground, and 2 suffocated on regurgitated food after the handling crew had departed. A hunter shot 2 additional wolves during the night following their capture, and we suspect those wolves, although probably standing, had not fully recovered from the effects of immobilization.

### **WOLF POPULATION SIZE AND TELEMETRY LOCATIONS**

#### *Jobs 4, 5, 6, 7 and 9*

The 1 November 1998 wolf population contained 169 wolves in 19 radiocollared wolf packs ( $\bar{x}$  = 8.9 wolves per pack) (Table 1). In addition, 5 collared wolves were not associated with packs but remained within the study area. Study area size in 1998 was approximately 11,275 km<sup>2</sup> as defined by a perimeter drawn around the territories of all 19 packs.

During autumn 1998, 56 radio collars were active on wolves within the study area. The collared sample was biased toward alpha pairs, with 28 of the 56 collars deployed on dominant animals. Of the remaining 28, 18 were deployed on subordinate wolves older than 1 year of age associated with packs, 5 were deployed on subordinate single wolves, and 5 were deployed on pups. The estimated composition of collared packs included 38 alpha animals (28 collared), 77 pups (5 collared), and 54 subordinates (18 collared). Assuming the proportion of single, subordinate animals among the collared subordinate sample was equal to the proportion of single subordinates among the noncollared subordinate sample, approximately 10 additional noncollared single wolves would be expected in the population. Therefore, the estimated wolf population within the study area, adjusted for noncollared singles, was 184 wolves (16.3 wolves/1000 km<sup>2</sup>) and the minimum known wolf population contained 174 wolves (15.4 wolves/1000 km<sup>2</sup>). Single wolves composed 8% of the adjusted estimate.

During 1 July 1998–30 June 1999, we recorded 1515 distinct wolf locations and 572 distinct pack locations during 90 days of telemetry flights, totaling 429 flight hours. Those included flights associated with kill rate studies, capture, densite monitoring, and general telemetry flights. Data from those flights have been entered into various databases for further analysis. Pack locations for each pack include only 1 den site location unless wolves used more than 1 den site.

## **PUP PRODUCTION AND SURVIVAL**

### *Jobs 2 through 5*

We captured 17 adult female wolves in early April 1999 and scanned each with ultrasound to determine pregnancy; 13 were pregnant (76%). Among the sample, 5 were dominant females in established packs, 5 were females of new pairs, 6 were subordinate females in established packs, and 1 female was a dispersing subordinate not associated with a pack. Among the females not pregnant, 3 were subordinates in established packs and the fourth was the lone dispersing female.

In utero litter sizes ranged from 2–9 fetuses in April 1998 ( $\bar{x} = 5.4$ ,  $n = 13$ ) and from 2–8 in April 1999 ( $\bar{x} = 5.3$ ,  $n = 13$ ). In 1998, 3 of 12 collared females, known to be pregnant in early April, failed to produce pups that survived until autumn. One pregnant female, killed by a hunter on 30 April, contained 5 full-term fetuses. Ultrasound scan of that wolf in early April had detected all 5 fetuses. None of the 1999 dens was viewable from the ground; litter size estimates and survival for 1999 pups will be estimated from late summer (Aug and Sep) counts at rendezvous sites and from traveling pack counts in autumn.

## **KILL RATES AND COMPOSITION OF PREY**

### *Jobs 2, 4, 6, and 8*

Ten sampling periods, totaling 39 flight days (29 sample days), were flown between 8 November and 18 March. We observed 18 moose, 4 caribou, and 2 Dall sheep kills on sample days. An additional 20 moose kills and 3 caribou kills were detected on the first day of the 4-day sampling periods, but those do not count as sampled kills because the date of kill was unknown. By helicopter, we visited 41 kill sites. Bone marrow samples were collected

from 17 moose kills. Samples were dried and weighed, and the data was entered into a database for analysis.

## **MORTALITY AND POSTMORTEM EXAMINATION**

### *Jobs 9 and 10*

Twenty-nine radiocollared wolves died during the reporting period; 25 died within the study area, and 4 were killed after dispersing out of the study area. Of the 29, hunters and trappers killed 25, 3 died of natural causes, and 1 died as a result of capture. Among the 3 natural mortalities, 2 (both males) were killed by other wolves and the third (an alpha female) died as the result of a single puncture wound to the neck that severed the jugular vein. Postmortem examination of the puncture wound did not reveal other bites or bruises on the carcass, and we speculate that the single puncture wound was inflicted by an antler tine from a moose or caribou. That female had been scanned by ultrasound in April 1998, and the ultrasound fetal count of 7 matched the placental scars observed during the postmortem examination.

During winter 1998–1999, we purchased 61 wolf carcasses (30 males and 31 females) from trappers and hunters. Twenty-four of those were pups. Carcasses of 11 adult collared females and 4 adult collared males were obtained from hunters and trappers. Three of the females had been scanned by ultrasound the previous spring: 1 was diagnosed as pregnant and 2 as not pregnant. Placental scars in reproductive tracts retrieved from the carcasses agreed with those diagnoses. However, in the pregnant female the fetal count as estimated by ultrasound (6) differed from that determined by postmortem examination (8).

## **CONCLUSIONS AND RECOMMENDATIONS**

By autumn 1998 the wolf population within the study area had recovered to precontrol (autumn 1993) population densities, despite continuous harvests by hunters and trappers since control ended in December 1994. Production and survival of wolf pups to autumn was high. Pups composed 42% of the estimated November 1998 population. Hunting and trapping are the primary sources of mortality within the study population. Those sources accounted for 88% of the mortality among collared wolves dying within the study area between 1 July 1998 and 30 June 1999. Natural mortality accounted for only 12% of the mortality among collared wolves within the study area. Moose, the most abundant prey species, were the primary prey among the 9 wolf packs intensively monitored throughout the winter.

## **ACKNOWLEDGMENTS**

Dave Baxter, Lem Butler, Bruce Dale, Lisa Fox, Cathie Harms, Kirstin Hunter, Laura McCarthy, Don Young, and Randy Zarnke assisted in collection of field or necropsy data. Laura McCarthy provided editorial expertise for this progress report. Pilots Bruce Dale, Jonathan Larrivee, Dennis Miller, Rick Swisher, and Marty Webb flew helicopter or fixed-surveys and provided logistical support for several aspects of this project.

## LITERATURE CITED

- ADAMS LG, BW DALE, AND LD MECH. 1995. Wolf predation on caribou calves in Denali National Park, Alaska. Pages 245–260 in LN Carbyn, SH Fritts, and D Seip, editors. Ecology and conservation of wolves in a changing world. Canadian Circumpolar Institute, Occasional Publication 35.
- BALLARD WB, JS WHITMAN, AND CL GARDNER. 1987. Ecology of an exploited wolf population in southcentral Alaska. *Wildlife Monographs* 98.
- \_\_\_\_\_, LA Ayres, PR Krausman, DJ Reed, and SG Fancy. 1997. Ecology of wolves in relation to a migratory caribou herd in northwest Alaska. *Wildlife Monographs* 135.
- BOERTJE RD, P VALKENBURG, AND ME MCNAY. 1996. Increases in moose, caribou, and wolves following wolf control in Alaska. *Journal of Wildlife Management* 60(3):474–489
- FULLER TK. 1989. Population dynamics of wolves in north-central Minnesota. *Wildlife Monographs* 105.
- GASAWAY WC, RO STEPHENSON, JL DAVIS, PEK SHEPHERD, AND OE BURRIS. 1983. Interrelationships of wolves, prey, and man in interior Alaska. *Wildlife Monographs* 84.
- HABER GC. 1996. Biological, conservation, and ethical implications of exploiting and controlling wolves. *Conservation Biology* 10(4):1068–1081.
- LEHMAN N, P CLARKSON, LD MECH, TJ MEIR, AND RK WAYNE. 1992. A study of the genetic relationships within and among wolf packs using DNA fingerprinting and mitochondrial DNA. *Behavioral Ecology and Sociobiology* 30:83–94.
- MECH LD, LG ADAMS, TJ MEIR, JW BURCH, AND BW DALE. 1998. The wolves of Denali. University of Minnesota Press.
- \_\_\_\_\_, TJ MEIR, JW BURCH, AND LG ADAMS. 1995. Patterns of prey selection by wolves in Denali National Park, Alaska. Pages 223–244 in LN Carbyn, SH Fritts, and D Seip, editors. Ecology and conservation of wolves in a changing world. Canadian Circumpolar Institute, Occasional Publication 35.
- MEIR TJ, JW BURCH, LD MECH, AND LG ADAMS. 1995. Pack structure and genetic relatedness among wolf packs in a naturally-regulated population. Pages 293–302 in LN Carbyn, SH Fritts, and D Seip, editors. Ecology and conservation of wolves in a changing world. Canadian Circumpolar Institute, Occasional Publication 35.
- MESSIER F. 1995. On the functional and numerical responses of wolves to changing prey densities. Pages 187–197 in LN Carbyn, SH Fritts, and D Seip, editors. Ecology and conservation of wolves in a changing world. Canadian Circumpolar Institute, Occasional Publication 35.

- NEILAND KA. 1970. Weight of dried marrow as an indicator of fat in caribou femurs. *Journal of Wildlife Management* 34(4): 904–907
- PACKARD JM AND LD MECH. 1980. Population regulation in wolves. Pages 135–150 in MN Cohen, RS Malpass, and HG Klein, editors. Biosocial mechanisms of population regulation. Yale University Press, New Haven, Connecticut.
- , ———, AND US SEAL. 1983. Social influences on reproduction in wolves. Pages 78–85 in LN Carbyn, editor. Wolves in Canada and Alaska: their status, biology, and management. Canadian Wildlife Service. Report Series 45.
- RAUSCH RA. 1967. Some aspects of the population ecology of wolves in Alaska. *American Zoologist* 7:253–265
- WOOLPY JH. 1968. The social organization of wolves. *Natural History* 77:46–55.

**PREPARED BY:**

Mark E McNay  
Wildlife Biologist III

**APPROVED BY:**

\_\_\_\_\_  
Wayne L Regelin, Director  
Division of Wildlife Conservation

**SUBMITTED BY:**

Kenneth R Whitten  
Research Coordinator

\_\_\_\_\_  
Steven R Peterson, Senior Staff Biologist  
Division of Wildlife Conservation

Table 1 Estimated pack size and number of autumn pups among 19 radiocollared wolf packs in Unit 20A, November 1999

Pack name	Estimated autumn pack size	Estimated autumn pups
West Fork	15	6
Yanert	7	2
Jumbo	15	5
Wells Creek	16	10
Dry Creek	9	5
100-mile	19	12
Dry Flat	14	8
Lignite	4	2
Tatlanika	14	6
Ptarmigan	7	4
Japan Hills	4	0
Moose Creek	11	5
Buzzard Creek	5	3
Slide Creek	2	0
Rockstadt	3	0
Sheep Creek	2	0
Paradise	6	0
Boulder	14	9
3-mile	2	0
Single wolves	5	0
Totals	174	77